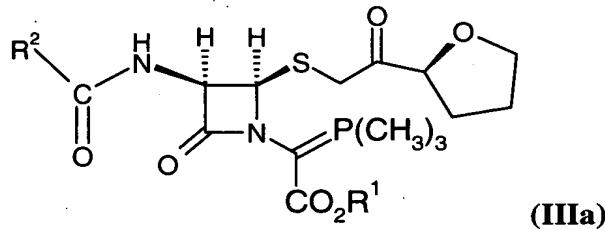


a) heating cyclizing a trimethylphosphinic compound of formula (IIIa)



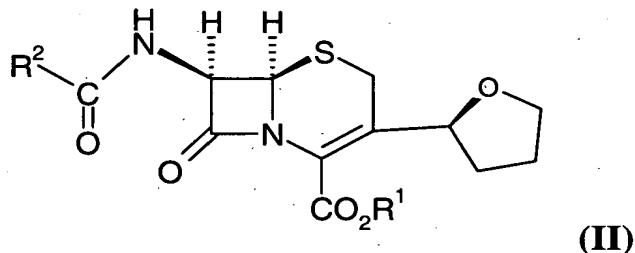
wherein

R¹ is *para*-nitrobenzyl or allyl;

R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl;

in a solvent;

to form a compound of formula (II)



wherein

R¹ is *para*-nitrobenzyl or allyl;

R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl; and

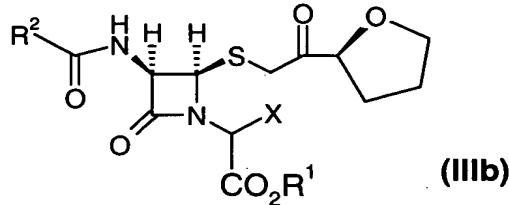
b) reacting said compound of formula (II) with an a Lewis acid of structure PX₅
wherein X is a halo group.

2. (ORIGINAL) A process according to claim 1, wherein said solvent is selected from

the group consisting of toluene, xylene, tetrahydrofuran, methylene chloride and acetonitrile.

3. (ORIGINAL) A process according to claim 1, wherein said acid is phosphorus pentachloride or phosphorus pentabromide; and wherein X is chloro or bromo.

4. (ORIGINAL) A process according to claim 1, further comprising the step of preparing said compound of formula (IIIa), by reacting a compound of formula (IIIb)



wherein said R¹ is *para*-nitrobenzyl or allyl,

said R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl; and

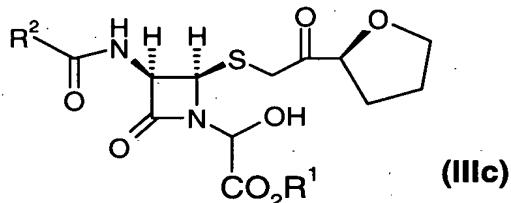
said X is halo;

with trimethylphosphine, in a solvent and in the presence of a base.

5. (ORIGINAL) A process according to claim 4, wherein said solvent is tetrahydrofuran, acetonitrile or methylene chloride.

6. (ORIGINAL) A process according to claim 4, wherein said base is selected from the group consisting of imidazole, 2,6-lutidine, pyridine, N-methylmorpholine and sodium bicarbonate.

7. (ORIGINAL) A process according to claim 4, further comprising the step of preparing said compound of formula (IIIb), by reacting a compound of formula (IIIc)



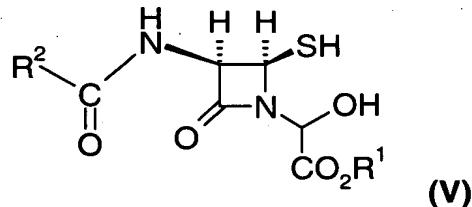
(IIIc)

wherein said R¹ is *para*-nitrobenzyl or allyl and said R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl; with a halogenating agent, in a solvent and in the presence of a base.

8. (ORIGINAL) A process according to claim 7, wherein said halogenating agent is thionyl chloride, thionyl bromide, phosphorus trichloride or phosphorus tribromide; and said halo is chloro or bromo.

9. (ORIGINAL) A process according to claim 7, wherein said base is selected from the group consisting of pyridine, 2,6-lutidine, N-methylmorpholine and imidazole.

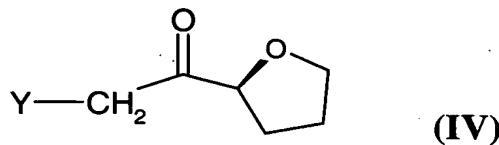
10. (ORIGINAL) A process according to claim 7, further comprising the step of preparing said compound of formula (IIIc), by reacting a compound of formula (V)



(V)

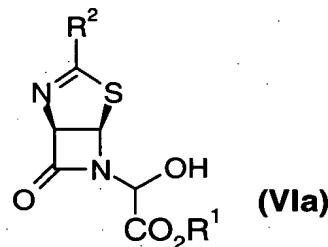
wherein said R¹ is *para*-nitrobenzyl or allyl and said R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl;

with a compound of formula (IV)



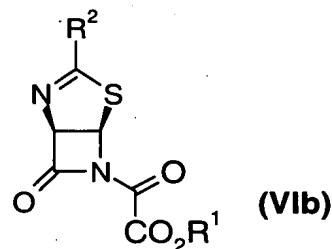
wherein Y is a leaving group selected from the group consisting of bromo, chloro, fluoro, iodo and tosylate; in a solvent.

11. (ORIGINAL) A process according to claim 10, wherein said Y is bromo or chloro.
12. (ORIGINAL) A process according to claim 10 wherein said solvent is alcohol selected from the group consisting of methanol, ethanol and propanol; methylene chloride; acetone; dimethylformamide or mixtures thereof.
13. (ORIGINAL) A process according to claim 10, further comprising the step of preparing said compound of formula (V) by reacting a compound of formula (VIa)



wherein R¹ is *para*-nitrobenzyl or allyl and wherein R² is selected from the group consisting of C₁-alkyl, C₆-10arylC₁-6alkyl and dithianyl; with an acid in a solvent.

14. (ORIGINAL) A process according to claim 13 wherein said acid is *para*-toluene sulfonic acid or methane sulfonic acid.
15. (ORIGINAL) A process according to claim 13 wherein said solvent is methylene chloride, tetrahydrofuran, acetone or mixtures thereof.
16. (ORIGINAL) A process according to claim 13 further comprising the step of preparing said compound of formula (VIa) by:
reacting a compound of formula (VIb)



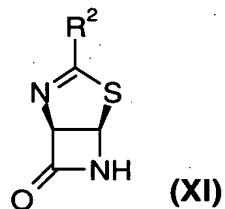
wherein

R¹ is *para*-nitrobenzyl or allyl;

R² is selected from the group consisting of C₁-alkyl, C₆-10aryl, C₆-10arylC₁-6alkyl and dithianyl;

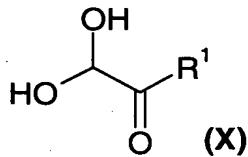
with a reducing agent selected from the group consisting of sodium borohydride, sodium cyanoborohydride, borane and sodium triacetoxy borohydride; in a solvent.

17. (ORIGINAL) A process according to claim 16 wherein said reducing agent is sodium triacetoxy borohydride.
18. (ORIGINAL) A process according to claim 16 wherein said solvent is acetic acid, methylene chloride, tetrahydrofuran, isopropanol or mixtures thereof.
19. (ORIGINAL) A process according to claim 13 further comprising the step of preparing said compound of formula (VIa) by reacting a compound of formula (XI)



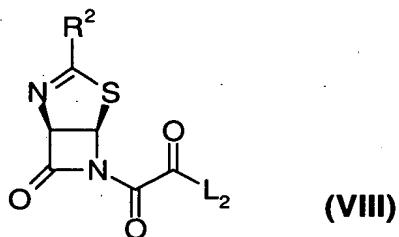
wherein R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl;

with a compound of formula (X)



wherein R¹ is para-nitrobenzyl or allyl; in a solvent; in the presence of a base.

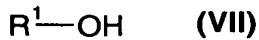
20. (ORIGINAL) A process according to claim 16 further comprising the step of preparing said compound of formula (VIb) comprising reacting a compound of formula (VIII)



wherein

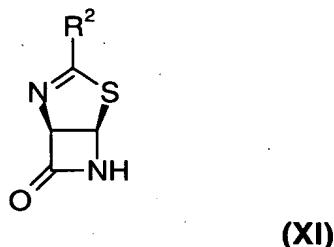
R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl;

L₂ is a leaving group selected from the group consisting of halo, azide and C₁₋₆alkoxy;
with a compound of formula (VII)

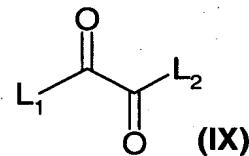


wherein R¹ is para-nitrobenzyl or allyl, in a solvent, in the presence of a base;

further comprising the step of preparing said compound of formula (VIII) by reacting a compound of formula (XI)

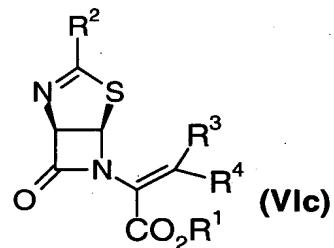


wherein R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl; with a compound of formula (IX)



wherein each of said L₁ and L₂ is a leaving group selected from the group consisting of halo, azide and C₁₋₆alkoxy; in a solvent, optionally in the presence of a base.

21. (ORIGINAL) A process according to claim 16 further comprising the step of preparing said compound of formula (VIIb) comprising reacting a compound of formula (VIc)



wherein

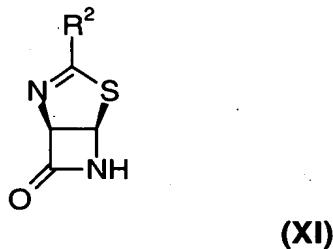
R¹ is *para*-nitrobenzyl or allyl;

R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl;

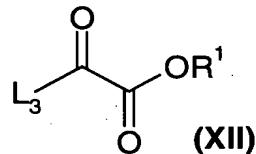
R³ is hydrogen or C₁₋₆alkyl; and

R⁴ is hydrogen or C₁₋₆alkyl; with ozone, in a solvent.

22. (ORIGINAL) A process according to claim 16 further comprising the step of preparing said compound of formula (VIIb) comprising reacting a compound of formula (XI)



wherein R^2 is selected from the group consisting of C_{1-6} alkyl, C_{6-10} aryl, C_{6-10} aryl C_{1-6} alkyl, and dithianyl; with a compound of formula (XII)



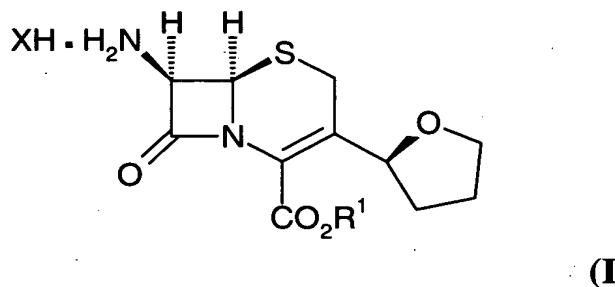
wherein

each of said L_3 is halo;

R^1 is *para*-nitrobenzyl or allyl;

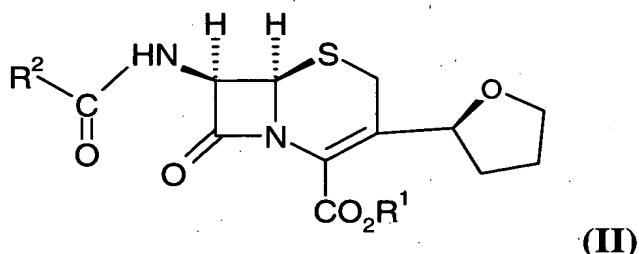
in a solvent, in the presence of a base.

23. (ORIGINAL) A process according to claim 20, wherein each of L_1 and L_2 , wherever each of them occurs, is halo selected from the group consisting of bromo or chloro.
24. (ORIGINAL) A process according to claim 21 wherein R^3 is methyl and R^4 is methyl.
25. (ORIGINAL) A process according to any of claims 7, 19-20 or 22 wherein said solvent, wherever it occurs, is methylene chloride, tetrahydrofuran or mixtures thereof.
26. (ORIGINAL) A process according to claim 21 wherein said solvent is methylene chloride, tetrahydrofuran, isopropanol or mixtures thereof.
27. (ORIGINAL) A process according to any of claims 19-21 wherein said base, wherever it occurs, is selected from the group consisting of diisopropylamine, triethylamine, pyridine and 2,6-lutidine.
28. (ORIGINAL) A process according to any of claims 1-27, wherein each of said R^1 , wherever it occurs, is *para*-nitrobenzyl.
29. (ORIGINAL) A process according to any of claims 1-27, wherein each of said R^1 , wherever it occurs, is allyl.
30. (ORIGINAL) A process according to any of claims 1-27, wherein each of said R^2 , wherever it occurs, is C_{6-10} aryl C_{1-6} alkyl.
31. (ORIGINAL) A process according to any of claims 1-27, wherein each of said R^2 , wherever it occurs, is benzyl.
32. (ORIGINAL) A compound of formula (I)



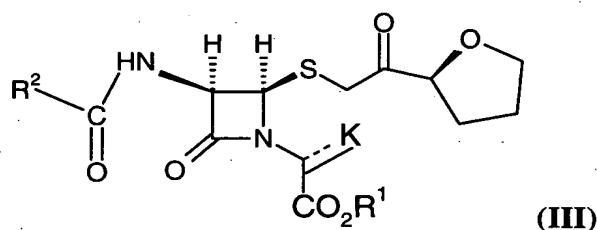
wherein R¹ is *para*-nitrobenzyl or allyl; and X is halo.

33. (ORIGINAL) A compound of formula (II)



wherein R¹ is *para*-nitrobenzyl or allyl; and R² is (C₆-C₁₀)aryl(C₁₋₆)alkyl.

34. (ORIGINAL) A compound of formula (III)



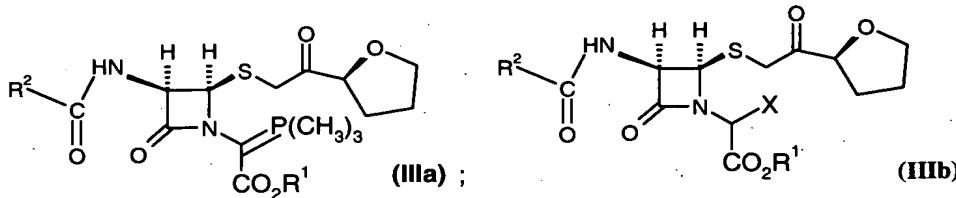
wherein R¹ is *para*-nitrobenzyl or allyl;

R² is (C₆-C₁₀)aryl(C₁₋₆)alkyl;

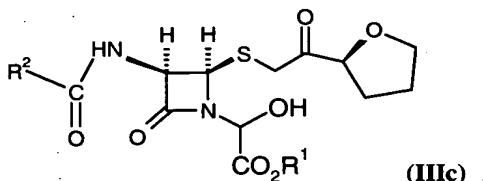
K is hydroxy, halo or -P-(CH₃)₃;

wherein the C-K bond is a single bond when K is hydroxy or halo; and a double bond when K is -P-(CH₃)₃; and

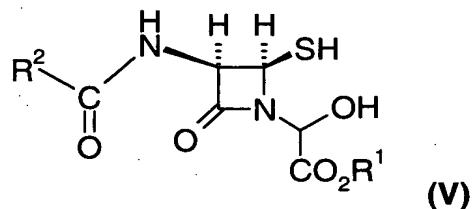
wherein said compound of formula (III) is selected from the group consisting of compound of formulae (IIIa), (IIIb) and (IIIc):



and

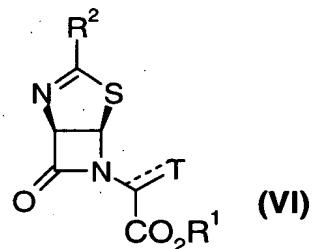


35. (ORIGINAL) A compound of formula (V)



wherein R¹ is *para*-nitrobenzyl or allyl; and R² is (C₆-C₁₀)aryl(C₁₋₆)alkyl.

36. (ORIGINAL) A compound of formula (VI)



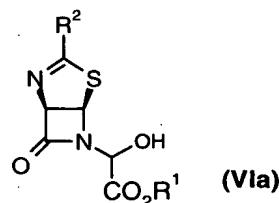
wherein R¹ is *para*-nitrobenzyl or allyl;

R² is (C₆-C₁₀)aryl(C₁₋₆)alkyl;

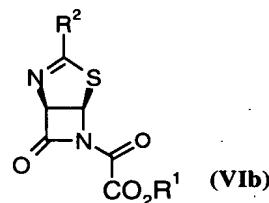
T is hydroxy or >O;

wherein the C-T bond is a single bond when T is hydroxy; and a double bond when T is >O ;
and

wherein said compound of formula (VI) is selected from the group consisting of compound of formulae (VIa) and (VIb):



and



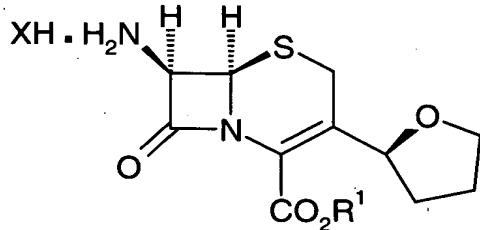
37. (CANCELLED)

38. (CANCELLED)

39. (CANCELLED)

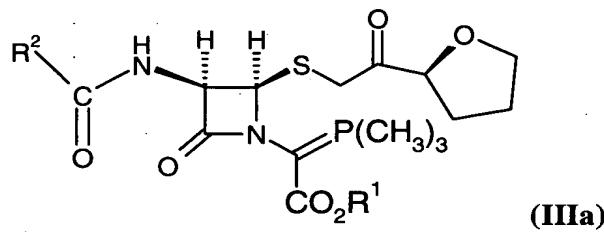
MARKED-UP COPY OF THE ABSTRACT OF THE INVENTION

This invention relates a process for preparing a compound of formula (I)



(I)

wherein R¹ is para-nitrobenzyl or allyl; preferably para-nitrobenzyl; and X is halo selected from the group consisting of bromo, chloro, fuloro and iodo, preferably chloro; by a) cyclizing a trimethylphosphinic compound of formula (IIIa)

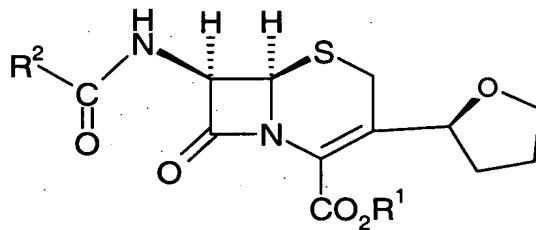


(IIIa)

wherein

R¹ is para-nitrobenzyl or allyl;

R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl; in a solvent; to form a compound of formula (II)



(II)

wherein

R¹ is para-nitrobenzyl or allyl;

R² is selected from the group consisting of C₁₋₆alkyl, C₆₋₁₀aryl, C₆₋₁₀arylC₁₋₆alkyl and dithianyl; and if desired

b) reacting said compound of formula (II) with a Lewis acid of structure PX₅ wherein X is a halo group, which is useful to prepare 3 cyclic ether substituted cephalosporins, from trimethylphosphinic compounds. This invention also relates to compounds useful in such